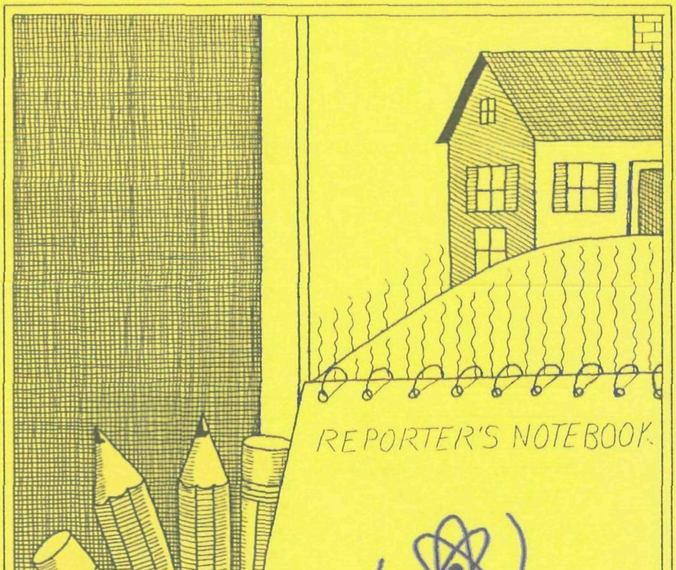
United States
Environmental Protection
Agency

520/1-89-026
October 1989

Air and Radiation (ANR-464)

EPA

Reporting on Radon



A Journalist's Guide to Covering the Nation's Second-Leading Cause of Lung Cancer

Environmental Health Center
of the National Safety Council

Printed on Recycled Paper

Reporting on Radon

A Journalist's Guide to Covering the Nation's Second-Leading Cause of Lung Cancer

Produced by:

The Environmental Health Center,
a division of the
National Safety Council

Under cooperative agreement
No. CX-815922-01-0
with the
Radon Division
Office of Air and Radiation
U.S. Environmental Protection Agency

Table of Contents

Preface

Radon As News:
Challenging Fundamental News Concepts?

Finding a cure for cancer would be big news. That's easy. Even a cure for some cancers would make banner headlines.

But when it comes to cancer *prevention*, as in avoiding radon-induced lung cancers, the story is different. In this context, radon flaunts the notion that an ounce of prevention is worth a pound of cure. As a news story, radon indeed challenges many of the fundamental concepts involved in the journalism riddle: "What is news?"

Rutgers University Environmental Communications Professor Peter Sandman recites a dozen factors involving how citizens and the media perceive environmental health risks. Collectively, they almost spell-out a challenge to the press's approach to what constitutes news when it comes to public health. Collectively, too, they help explain why many feel radon-induced lung cancers are among the most under-reported cancer risks.

As for challenging fundamental news precepts, consider a few of the factors Sandman cites:

There is no villain. No one *puts* radon into the environment. No industry emits or releases or spills radon into the environment. Radon occurs naturally in most soils and rocks. It enters individual homes and buildings through cracks and fissures common to many structures. Those cracks and fissures are the "fault" of no one in particular.

There is no "victim." You can't point to a lung cancer victim and conclude that radon was the cause of death. Cancer deaths come with no "Radon-Induced" label. Radon's lethal effects are chronic rather than acute; they show up as lung cancer only after decades. In those cases, showing a cause-and-effect relationship is impossible.

There is usually no immediate emergency, and "control" of the problem rests with the individual. In most cases, there's no additional cancer risk from radon by waiting a day or a week or more before reducing the radon concentrations in one's environment. The risk here is controlled not by some outside force upon whom pressures can be brought, but rather by the individual. Call it human nature: Because the timing is up to the individual, the problem often goes unaddressed. "I can do it tomorrow, so I won't do it today . . . . "

The threat is unseen and unfelt, and the risk occurs in that most unlikely and most trusted of places . . . at home. Radon is invisible. People can't see, taste, or smell it. It doesn't repulse them physically or offend their senses. Rather, it lurks silently in the background, working its mischief only after years of exposure. And it does so often in that haven where people feel most safe . . . the home. That fact creates a psychological barrier against seeing a familiar situation as a risky one.

From a journalistic standpoint, the irony is that the radon health risk issue has arisen at a time when much of the public feels powerless to address and manage many of the environmental health risks they perceive as harming them the most. And yet here is one that they can control. Although radon is the nation's second leading cause of dreaded lung cancer, informed citizens have the wherewithal to assess and, if necessary, reduce their own exposure risks easily and usually inexpensively. They can do so without incurring large capital expenses and without enduring difficult life-style changes.

Reporting on Radon has key information reporters need to communicate effectively on the nation's second leading cause of lung cancer. It provides a "one-stop read" on the environmental cancer risk that outnumbers all others in annual mortalities. This guide also raises the question of whether radon is an under-reported news story precisely because it challenges traditional approaches to evaluating the newsworthiness of environmental health issues.

One point is obvious: The public depends on the media for their understanding of environmental health risk issues. Citizens will understand an issue no better than the reporter himself or herself does. A second essential point: informed citizens, actively involved in environmental risk policies, are the key to making environmental programs work in the first place. The media's role in that process is critical.

That point -- informed citizens actively engaged in managing environmental risks -- is particularly relevant to radon, given that radon risks in the end can be individually controlled. Audiences besieged with countless threats over which they have little control will find radon an exception to that general rule.

Reporting on Radon was prepared by the National Safety Council's Environmental Health Center (EHC) with a grant from the U.S. Environmental Protection Agency's Radon Division, Office of Air and Radiation. The National Safety Council is a 76-year-old not-for-profit, nongovernmental public service organization, headquartered in Chicago.

This guide is part of a continuing series of environmental journalism activities undertaken by the Environmental Health Center since its establishment in January 1988. EHC also has published a reporters' guide on coverage of community chemicals, and each month it publishes *Environment Writer*, a newsletter aimed exclusively at print and electronic journalists covering environmental health and pollution control issues.

EHC appreciates the substantive contributions to this reporters' guide from free-lance writers and researchers Rob Taylor, former environmental reporter for *The Wall Street Journal*; Lani Sinclair; and Harold I. Sharlin. In addition, EHC benefited substantially from critical reviews by Los Angeles-based science writer Sandra Blakeslee and by San Jose, California, environmental journalist Mitchel Benson of the *San Jose Mercury News*.

EHC in particular appreciates the commitment of EPA project manager Peyton Lewis, in the Radon Division, to protecting the journalistic integrity and purpose of the guide. The approach by her and her colleagues in the Radon Division is testimony to their expressed commitment to effective environmental journalism.

Bud Ward
Executive Director,
Environmental Health Center

Introduction

Radon -- The Uninvited House Guest

Radon may be our most underestimated cause of cancer.

In a Roper poll reported early in 1988, Americans rated radon second lowest of 28 health threats, just ahead of microwave ovens. Almost half the people surveyed said radon posed little or no risk, or said they didn't know.

In fact, many scientists say radon should lead the list of environmental public health risks. This radioactive gas is blamed for causing more lung cancer deaths than any other single pollutant except tobacco smoke. Some 20,000 Americans die each year because of radon-induced lung cancers, the Environmental Protection Agency now estimates. That figure means that radon causes more mortalities than any other environmental pollutant under the agency's vast jurisdiction.

Despite the risk, governments are unlikely to take direct regulatory responsibility for radon control, but are more likely to assess radon risks and advise the public on appropriate actions. The job is mammoth, with this uninvited guest turning up in homes almost everywhere. In many ways, radon problems are ideally suited for individual response and action. And there's no industry to carry blame or bill for damages. So officials have assessed radon risks and have told the public what it needs to know to take effective action. Beyond that, however, it is primarily up to individuals to investigate their own radon problems and solve them.

For most of us, however, that's not easy.

In fact, most people have done nothing. Sure, testing spurts from time to time in response to flurries of news media interest. But to date, few U.S. homes have even been actually tested, and even fewer homes have been "mitigated" to reduce radon levels.

The slow response isn't unusual. Findings on cancer risks are complicated, especially when it comes to separating big risks from the small. Many consumers are skeptical or numbed by the drumbeat of cancer alarms. Look how long cigarette smoking has lingered.

All this magnifies the news media's role. If they don't explain radon's risks and put them into perspective with other environmental risks, few people will protect themselves. Without "news you can use" on how to test and fix radon problems, even many interested consumers will remain confused and frustrated.

Robert Taylor
(former environmental reporter)
The Wall Street Journal
Washington, D.C., bureau

Chapter 1

Understanding Radon: The Four W's -- What, Where, Who and When --

Summary

- *A radioactive gas, radon occurrs naturally in most rocks and soils. It can be found at various concentrations practically anywhere on earth, but it's when concentrations rise in closed-in buildings that health risks become a concern.*

- *Radon is at the root of the problem, but the resulting lung cancers actually arise as a result of two of radon's decay products, isotopes of polonium. These so-called radon "daughters" or "progeny" lodge deep in the lungs and emit damaging alpha radiation. That can be the onset of a lung cancer manifested only years or decades later.*

- *The "Reading Prong" in the mid-Atlantic states has become something of a household term in public health circles because of perilously high radon levels. But scientists caution now about thinking that radon risks are isolated to a few geographical "hot spots."*

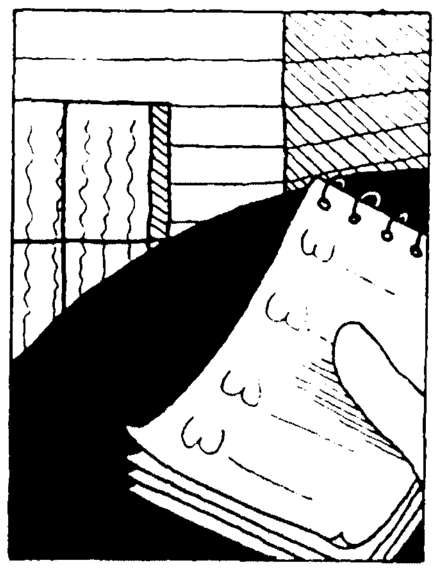
- *Radon risks can endanger "anyone who breathes." The cancer risks dwarf those responsibly linked to most other environmental pollution problems. The young and smokers are especially at risk.*

- *The federal government has established a level of four picocuries of radon per liter of air as a guidance deserving follow-up actions. But it would be a mistake to suggest that a level of "four" is safe or free of the risk of inducing increased incidences of lung cancer.*

- *Radon-induced lung cancers, like all cancers, are chronic rather than acute. That is, they develop only after prolonged exposures.*

Chapter 1

Understanding Radon: The Four W's --What, Where, Who and When--



What is Radon?

Radon-222 is a radioactive gas. Humans can neither see, smell, nor taste it, but it turns up almost everywhere.

Radon occurs naturally in rocks and soil. Radon atoms are uranium's direct descendants. When atoms of uranium-238 decay, they produce several generations of other radioactive elements. The fifth generation is radium, which in turn decays into radon.

Though great concentrations of uranium are rare, traces of it are common in ordinary rock and soil. Concentrations vary. But on average, about six atoms of radon emerge each second from every square inch of soil. A typical concentration of radon in soil is between 500 and 1,000 picocuries per liter of air (pCi/l).

Radon Geology for Journalists

Geology isn't routinely taught as part of the journalism curriculum on the nation's campuses. And it's not a subject most reporters feel comfortable discussing as a result of things they've learned along the way.

But understanding a couple of fundamental principles of geology will help reporters better understand and communicate on radon-related health risks. Each principle is, says the Consumer Reports book *Radon: A Homeowner's Guide to Detection and Control*, "highly unpredictable."

The first principle: There has to be a fairly rich concentration of uranium in the soil to find very high radon concentrations in homes. The existence of natural concentrations of uranium in the soil is a function of chemical characteristics that have occurred over millions of years. But when a uranium atom underground is transformed into a thorium atom, a series of protracted but successive decay processes gets underway; over a few hundred thousand years, the result is radioactive radium. The radium itself decays into another radioactive element -- radon -- and it is radon, by now a surface coating on underground rocks, which then can percolate through the ground.

Some rocks and soils contain more uranium than others, though all contain at least trace amounts. Consumer Reports' *Radon* book, for instance, says rock routinely has about 2.7 pounds of uranium for each million pounds of rock. Granite, on the other hand, has about 4.7 pounds per million pounds, shale about 3.7 pounds. Compare that with sandstone and basalt, for which the average is 0.5 and 0.9 pounds of uranium per million pounds, respectively.

But the evolution of radon isn't just another link in a monotonous chain. It is instead the single critical event in that chain. Unlike its solid ancestors, radon is a gas -- it's mobile. The slightest fissure in surrounding rock is enough to spring radon gas from its centuries-old prison in the earth. It can move to the surface with other soil gases. From there it is free to wander.

In the open air, most radon dilutes into insignificant concentrations. But trapped and allowed to concentrate, as when it continues to move up through the ground into a house, radon becomes a serious public health problem.

Within a single rock formation, however, the range of uranium concentrations -- and therefore of radon -- can vary widely. As a result, geologists have difficulty in predicting just which areas may have high radon levels in the ground.

The second geological principle: Radon concentrations built-up in underground soils and rocks might remain there harmlessly were it not for pathways that enable the radon to move through the ground. Radon -- a fifth-generation decay product derived from uranium -- has a half-life of about 3.8 days. Half of it will decay in 3.8 days and half of the remaining radon then decays over the next 3.8 days, and so forth.

Tightly packed or wet soils or clay, for instance, impede radon's movement to the ground surface. Provide radon even microscopic cracks or fissures through the soils, however, and radon atoms move more freely through the ground. It's at the ground surface that radon can pose a risk to an individual home. For the unfortunate, the radon atoms may find their way through building cracks and openings into enclosed areas . . . where high radon concentrations can pose increased lung cancer risks.

Those two geological factors in combination -- normal to high uranium concentrations and easy access for uranium's decay products to the ground surface and into homes -- pose the radon/lung cancer problem. Together, they account for thousands of preventable lung cancer cases each year.

Actually, most radon found in homes poses no direct hazard. It has a relatively short half-life of 3.8 days, meaning that by emitting radiation, half the radon atoms evolve into another element in less than four days. Its very mobility protects us from its radiation. Though we breathe it into our lungs, it tends to pass back out harmlessly as we exhale.

The deadly threats stem from two of radon's decay products, solid isotopes of polonium. Because they revert to solid form, these radon decay products can be inhaled and can lodge deep in the lungs. There they linger like tiny time-bombs. And since they have half lives of no more than a few minutes, they tend to "go off" before the lung can clear them.

The harm itself results when the polonium isotopes emit high-energy, low-velocity particles called alpha radiation. These same alpha particles constantly bombard our bodies from outside without harm; most cannot penetrate the dead outer layer of our skin. But breathed deep into the lung, they can radiate and penetrate sensitive and vulnerable lung tissue.

At equal concentrations of radioactivity, alpha particles, once inhaled or ingested, are far more deadly cancer producers than beta and gamma radiation. They move more slowly and deposit their energy over a shorter distance. When alpha particles slam into unshielded lung cells, they can sever strands of DNA's double helix corkscrew, scrambling its genetic code. Cells are efficient at repairing breaks in a single strand, simply copying the other, according to David J. Brenner of Columbia University's Radiological Research Laboratories. But damage from double-strand breaks, he says, "may be permanent and may be transmitted to the cell's daughters."

The effects may not be seen for years, or even decades. But ultimately the damage causes certain cells to lose control over cell division and growth. This dysfunction -- cell multiplication without control -- is the health risk associated with exposures to radon and its "progeny," and radon has been identified as the second leading cause of lung cancers, behind smoking.

Where is Radon?

The Pennsylvania woman looked confused. "How," she asked after an hour-long speech on radon, "do they get the radon from nuclear power plants into the ground and over into the houses?"

In fact, "they" don't. Radon occurs naturally almost everywhere. Current estimates are that the average U.S. home contains about 1.5 picocuries, but averages, as always, can be misleading. In "hot spots" home readings soar over 2,000 picocuries per liter (pCi/l). Radon readings tend to range highest in areas with high concentrations of uranium-bearing rocks, such as granites, but there are plenty of exceptions to that rule.

To help people interpret radon readings, the U.S. Environmental Protection Agency initially established four picocuries per liter of air as a rough annual average guideline. The agency was not telling people that a level of 4 pCi/l was "safe" and that lower levels might not still lead to increased incidences of lung cancer. Rather, the figure was essentially a technology-based figure based on the agency's assessment of what concentration could be achieved with existing radon reduction technology and practices.

The agency urged people with higher readings to confirm them with further tests and to cut radon below that level with generally routine construction work or repairs. There continues to be debate and controversy over the meaning of the "four picocuries" guideline. Some members of the U.S. Congress feel strongly that EPA's guideline can create a false sense of security and that it in fact must not be seen as implying a level of "safety." They prefer a lower threshold, and there are indications that EPA is moving toward establishing a series of radon action levels, including some below 4 pCi/l.

Initial screening tests conducted by EPA in some states indicates some alarmingly high proportions of homes exceeding the four-picocuries guideline. In Minnesota and North Dakota, 46 and 63 percent of the homes screened were found to have screening levels above the 4 pCi/l guideline. The average screening level found in North Dakota home tests was a surprisingly high 7 pCi/l, almost doubling the EPA threshold.

On the other hand, low levels are common in some states. In Alabama, for instance, radon screening levels reached the EPA's "action level" in only 6 percent of the homes EPA tested. Even at that low rate, however, hundreds of Alabama households would benefit from radon testing. Furthermore, despite the low radon readings for most Alabama households, one house tested there recorded a 180-picocurie per liter reading!

Some critics have warned that these short-term screening measurements may be poor indicators of radon hazards. EPA and these critics point out that radon can fluctuate widely over a short period of time. They say that only long-term tests providing annual average radon concentrations provide responsible measures of potential radon health risks. EPA itself is beginning to systematically conduct long-term tests in its National Survey.

Variations within regions, states and even neighborhoods unquestionably make radon levels hard to predict for a given home. In the mid-1980s, some scientists tried to map radon-prone areas from geologic data. But even when broader measurements became available in 1986, high and low readings proved far less reliable than many had hoped in providing accurate predictions of high radon concentrations. The problem was that high radon measurements could be found in areas mapped as being unlikely to have a problem . . . and low readings found in areas thought likely to have a serious problem. As tools for state and local government strategies, and for shaping national radon policy, the maps provide an excellent policy tool, but they are not useful in terms of anticipating concentrations in a particular home.

Under its Radiation Action Program, initiated in 1985, EPA has been working with the U.S. Geological Survey to provide states with geological data they can use in surveying for radon. EPA by mid-1989 had surveyed 25 states, and the agency says it now is confident that geology "is a good indicator of potential high indoor radon levels." Testifying before a House Interior and Insular Affairs Subcommittee on oversight and investigations, EPA Office of Radiation Programs Director Richard Guimond emphasized that geological information alone, however, "is not enough. We need a combination of geology and indoor radon measurements to provide a full understanding of the scope and magnitude of the radon problem."

While much of the public and media focus on radon has concentrated on homes, the potential radon problem goes beyond just personal residences.

It turns out that homes aren't the only places where radon is a problem. An initial EPA survey of 131 schools in 16 states found 19 percent of schoolrooms had screening levels exceeding 4 pCi/l, with the highest reading at 136 pCi/l. The schools tested, however, were not chosen to necessarily represent a cross-section of all the nation's schools, and it is possible that typical school radon levels will be different. Under the Indoor Radon Abatement Act, passed in 1988, the agency is to list high radon risk areas in order to evaluate radon contamination in schools. EPA will use geological and indoor radon data to conduct a survey of radon in schools.

Mostly, radon gets into buildings through basement and foundation cracks, drains and joints. Because it can dissolve in water, however, radon also can ride into kitchens and bathrooms in water drawn from private wells. When the water sprays from a faucet, aeration again releases radon into the air, where it sometimes builds up to high levels in the air.

Radon in water accounts for between 1 and 3 percent of the radon health problem, and most of the problem occurs in homes in the northeastern United States. However, homes relying on private wells probably should test for radon as a precaution.

People living above the second floor may be able to relax in terms of residential radon. Radon dilutes as it moves upward within a building. Under closed-house conditions, radon readings in basements tend to be about double those on the first floor. Unless a central heating and air conditioning system or water is bringing in most of the radioactive gas, readings in second floor and above drop off even more sharply.

Who is at Risk From Radon?

Anyone who breathes. The risk grows with the level and duration of radon exposure.

Risks resulting from exposure to radon are far greater than risks posed by most other dangerous substances. Take people who spend a lifetime in homes with a relatively high radon level of 20 pCi/l. Scientists say they face about the same cancer risk as people who smoke about one and a half packs of cigarettes per day; six in 100 may die of lung cancer as a result of exposure to radon, according to EPA. By contrast, federal agencies usually crack down on exposure to a chemical only when it is thought to cause cancer deaths in more than one person in a million.

It is fortunate that 20 pCi/l has been found in only 2 percent of the more than 20,000 homes where the EPA conducted screening tests, according to the EPA.

But, as mentioned above, even at 4 picocuries per liter -- EPA's initial trigger for recommending radon reduction -- radon exposures aren't "safe." In fact, "that level still has a fair amount of risk," says Richard Guimond, director of EPA's Office of

Radiation Programs. The EPA says it poses almost the same risk as smoking a half-pack of cigarettes a day -- it will cause fatal lung cancer in as many as 3 percent of the people exposed for a lifetime.

Notwithstanding EPA's caveats, many in EPA and Congress are concerned that the four-picocuries guideline unintentionally encourages people to ignore the risks at or below that level. Having initially chosen that guideline because they feared contractors might be unable to achieve a lower level, agency staff point to new experiences demonstrating that contractors now can cut high radon levels well below the EPA threshold. Encouraged by Congress, the agency is expected to issue added warnings on the danger of levels lower than 4 pCi/l.

Some people need to worry more about radon than others. The National Academy of Sciences estimates the risk of lung cancer from radon is up to 10 times higher for smokers than non-smokers, perhaps because radon decay products can hitch a ride into the human lungs on tobacco particles that remain suspended in smoke.

Children also may be more vulnerable to radon. They have a longer life-span to allow latent cancers to become malignant growths, they breathe faster, and their rapidly-dividing cells may be more vulnerable to radiation damage. The International Council on Radiation Protection estimates that children and youths under 20 years old face triple the adult risk.

When was the Radon Threat Discovered?

Underground miners have been dying of radon-induced lung cancers for centuries, but it wasn't until the 1950s and 1960s that the two were clearly linked.

In response, U.S. regulators first set rules for reducing mine radon levels by ventilation. In the 1970s health officials also turned to cleaning up uranium mill tailings that continued to emit radon, including some that had been used as foundations for homes.

Acute Versus Chronic Hazards

An important part of the "when" of radon involves just when its health effects are manifested. In scientific jargon, exposures that cause illness or death within days or weeks are termed acute hazards. Hazards that cause effects such as cancer long after low-level exposures are termed chronic. Even the highest radon exposure levels are chronic rather than acute hazards.

Radiation poses acute hazards at short-term whole-body exposure of more than 150 rem. (According to current estimates, exposing the lung to four pCi/l of radon in air for one full year carries about the same risk as exposing the entire body to one rem of radiation.) A person hit with 5,000 rem of radiation suffers an incoherent fit along the lines of an epileptic seizure. Death follows within a few days. Survival is still unlikely with exposures as low as 600 rem, which produce nausea, vomiting and malaise. The symptoms may ease temporarily, then return with a vengeance. The victim's hair falls out. Often, the weakened victim falls prey to an infection.

Most people will show little or no immediate acute effect from exposure to 100 rem or less of radiation. These and smaller doses of radiation cause subtle, cumulative damage that tends to lie dormant. Even tiny amounts of radiation may add to the cancer risk. Though some scientists believe that cells can repair damage from small amounts of radiation, the prevailing scientific view is that no amount of radiation may be considered "safe."

The hazard from chronic low-level exposure to radiation stems from short-term damage it does to cells' DNA, or genetic code. The harm can often remain invisible for decades. Then, perhaps with the assistance of a substance that "promotes" rather than "initiates" cancer, some descendants of the damaged cells abandon their control of cell growth and division.

To estimate the risk of cancer from radon, scientists studied underground miners who breathed high radon levels in their work. The studies uniformly conclude that these miners suffered lung cancer more often than the general public, and most studies found the incidence of cancers was directly related to the radon exposure.

Using these data and estimates of home radon levels, the Environmental Protection Agency has estimated that radon causes approximately 20,000 U.S. lung cancer deaths each year. That puts it second only to smoking as a cause of lung cancer, the leading cancer killer. Lung cancer is expected to kill 160,000 people in 1989, according to the American Cancer Society.

But officials showed little interest or concern in naturally occurring radon in homes until 1984, after nuclear plant worker Stanley Watras set off alarms that shocked the public health world.

Mr. Watras had dumbfounded workers at the Limerick, Pa. nuclear plant by repeatedly triggering radiation alarms. Eventually, his colleagues and employer became startled that he was bringing radiation *into* the plant. When Watras tested his home, he discovered the highest residential radon level ever found until that time -- 2,700 pCi/l.

"The Watras incident really changed the ballgame," says the EPA's Guimond. Homes built on mill tailings had registered up to 100 to 200 pCi/l, he recalls. "We thought the highest naturally occurring radon in homes would be no more than one-tenth of that."

The Watras incident set off a house-to-house search for radon. Initially, concerns focused on a uranium-prone geologic formation called the Reading Prong, stretching across eastern Pennsylvania into northeastern New Jersey. But in 1986, as radon readings trickled in from around the U.S., risky radon levels turned up in all regions tested. "Hot spot" clusters of homes, with radon readings of hundreds and even thousands of picocuries per liter, were found in several states.

U.S. officials agreed that radon isn't just a local problem, but a national one. Indeed, testing in Europe demonstrated that it is international. Radon, people discovered, respects no boundaries.

Chapter 2

Testing for Radon: Appropriate Follow-up Actions

Summary

- *As a personalized environmental threat potentially affecting neighboring individuals differently, radon is unique among environmental public health risks.*

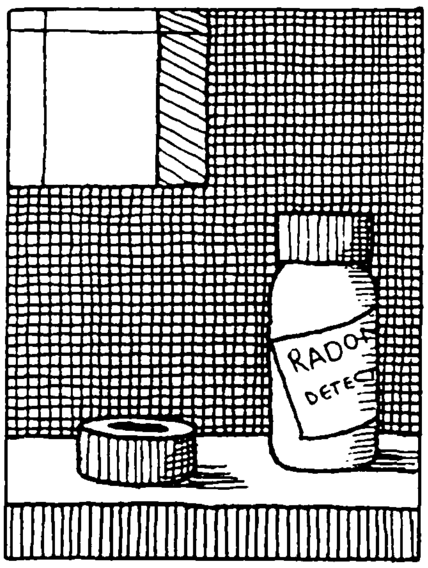
- *Testing for one's own radon risks is economical, and repairs, when necessary, are usually inexpensive, in line with many other "routine" household maintenance and repair projects.*

- *Short-term tests of just a few days offer an effective screening indicator of the extent of potential radon concentrations. However, because radon levels in a home fluctuate widely over time, long-term readings over the course of several seasons provide the most reliable indication of annual exposure levels.*

- *Varying ranges of radon concentrations will justify a series of responses depending on the severity of the problem. Some short-term steps can be taken immediately while a long-term solution to high radon readings is considered and undertaken.*

Chapter 2

Testing for Radon; Appropriate Follow-up Actions



Unlike smog or stratospheric ozone depletion, radon is a personalized environmental threat, one that potentially affects next-door neighbors in far different ways. The threat comes not from the vapors of the sky or the vastness of the atmosphere, but from one's own home.

Now that do-it-yourself radon tests are economical, easy to use, reliable, and readily available, most homeowners can -- and should -- measure the radon levels in their homes. A neighbor's low radon reading is *not* a substitute for a reading in an adjacent or nearby home; differences in houses and underlying soil can produce widely varying radon levels in neighboring houses.

Given the relative ease and economy of radon testing and the unpredictability of high radon concentrations, EPA and the Office of the Surgeon General of the United States recommend that most homes be tested. Only testing, they say, provides homeowners a level of confidence about the potential radon exposures they personally face.

How to Test

To better report on radon-related lung cancers, reporters need to understand how testing and radon reduction actually work.

The most popular commercially available radon detectors are the charcoal canister and the alpha track detector. However, a variety of different measurement methods is available for determining radon concentrations.

Charcoal canisters usually are used for making short-term measurements of two to seven days. Alpha track detectors measure radon for a minimum of a month, but more often for three to 12 months. Both devices are then sent back to the manufacturers' laboratories for analysis. Results are reported either in "working levels" of radon (WL), or "picocuries per liter" (pCi/l) of radon gas.

Definitions

Picocurie . . . A curie is a standard measurement for radioactivity, specifically the rate of decay for a gram of radium -- 37 billion decays per second. A picocurie (pCi) is one millionth of one-millionth of a curie.

Working Level . . . A working level, derived from safety and health regulations covering mining, is a measurement of radon decay products, rather than of radon itself. Roughly, one picocurie per liter of radon gas is the same as 0.005 working levels. So 1 working level (WL) is equal to about 200 picocuries of radon gas. The term itself generally is used less often than picocuries as a unit of measure.

Decay Product... Radioactive materials degrade to give rise to decay products, often referred to informally as "daughters" or "progeny." The radon decay products of most concern from a public health standpoint are polonium-214 and polonium-218.

In addition to the charcoal canisters and alpha track devices most familiar to the general public, other devices also can be used to measure radon concentrations. Continuous radon monitoring methods, for instance, use an electron detector to accumulate and store periodic radon concentrations. Installed in homes according to specified federal procedures, they can be used only by a skilled operator. While generally very precise in their measurements, these continuous monitoring methods cost much more to use than the charcoal canister or alpha track, and they are susceptible to sampling errors.

Another measuring device is the "E-PERM," an acronym for the "Electret Passive Environmental Radon Monitor." Installed in the home for two to seven days or three to 12 months for short- and long-term E-PERMs respectively, these devices contain a charged electret which reacts to radiation from radon and radon decay products. Once exposed for the specified amount of time, they are resealed and sent to an analytical laboratory for evaluation.

Some state or local governments provide radon detectors to homeowners either at no charge or at a reduced cost; many hardware stores, grocery stores and mail-order firms regularly stock several varieties of detectors.

Though instructions vary according to which type of device the homeowner has chosen, several basic rules apply to radon measurements:

- EPA-listed detectors should be used.

- The *most accurate* way to estimate the annual radon level in your home is with a long-term test over a one-year period in the area(s) of your home where you spend most of your time. Alpha track detectors and electret ion detectors are the most common long-term testing devices.

- The *fastest* way to find out if you have a radon problem is to place a short-term testing device in your home for a few days to several months. However, short-term tests should only be used in the lowest living area of the home, with doors and windows closed, during the cooler months of the year. This process reduces the chance of measuring the home when radon levels are lower than usual. Charcoal test kits and electret ion detectors are the most common short-term testing devices.

Deciding Whether to Fix Your Home

Because no level of radon is considered absolutely "safe," a person should try to reduce radon levels in his or her home as much as possible and practical. The average radon level in homes is about 1.5 pCi/l. A person should definitely take action to reduce radon if the *average annual level* is higher than 4 pCi/l.

The table below shows what radon reductions are possible.

You can expect to achieve:

2 - 4 pCi/l	In most cases
less than 2 pCi/l	Sometimes

Using Your Test Results

The EPA originally developed a 4 pCi/l guideline for action which was based on the technology available at that time. The agency did not recommend short-term measurements as a way of estimating health risks, but rather recommended long-term testing.

In October 1988, Congress passed the Indoor Radon Abatement Act which called for EPA to do away with action levels and to begin researching whether short-term measurements can predict annual average concentrations.

After preliminary research, EPA developed some of these correlations, and offered this guidance:

Short-term test results and long-term results should be interpreted differently. If long-term test results are elevated, one should take action to lower the radon level in the home.

If short-term test results are elevated, the best way to determine the annual radon level is by measuring again over a one-year period. Preliminary research shows that short-term tests generally overestimate annual levels by one to three times:

If Short-Term Result (pCi/l) Is:	Then Estimated Annual Radon Level (pCi/l) Is:		
1	1		.3
2	2		.7
3	3	-	1.0
4	4		1.3
5	5		1.7
6	6	-	2.0
7	7	-	2.3
8	8	-	2.7
9	9	-	3.0
10	10		3.3
11	11	-	3.7
12	12	-	4.0

If the short-term test results are low, a person may want to test again. This is to make sure that the test was not conducted at a time when radon levels happened to be much lower than usual.

Some scientists believe that this guidance is an intermediary step. After more research is completed, they think it may be possible for EPA to recommend taking action based on a short-term measurement.

Things to Consider

In addition to testing radon levels, a homeowner concerned about radon exposures, while considering and taking specific actions, should ask several questions to determine radon risk:

- Does anyone in the household smoke?
- Are there children in the family?
- Do people spend unusually high amounts of time in the home, perhaps because of individual illnesses, age, occupation or personal preference?
- Does anyone sleep in the basement, where radon levels are higher than on other floors?

The more affirmative answers a homeowner has to these questions, the sooner he or she should act to reduce the radon levels of the house.

Measuring for Radon

Measuring for radon is easy, and generally quite reliable, though one must be careful not to read too much into short-term radon tests.

For most persons, use of a short-term test kit or measuring device over a period of two to seven days is an effective way to begin understanding potential individual radon risks. Charcoal canisters, for instance, are exposed to air in a room, and the charcoal adsorbs radon gas. The kits then are mailed back, air-tight, to a laboratory, which measures them for radioactivity. That allows an evaluation of the level of radon to which a kit was exposed.

It may be helpful for reporters and their audiences to think of these tests as providing something of a snapshot of the radon situation in a particular home. While radon levels in a home vary widely from room-to-room, day-to-day, and season-to-season, short-term devices will provide homeowners with what EPA calls a "screening measurement" aimed at helping them determine whether they have a potential problem. They cannot identify the *specific* extent of a problem, but rather help identify the potential for a radon problem.

A short-term screening measurement of more than four picocuries per liter of air likely will warrant additional testing, while substantially higher measurements would justify three-month testing to see if the high radon levels are confirmed. The three- to 12-month test should provide an ample indication of the seriousness of the problem, without unduly prolonging high exposures.

Unlike the short-term tests, longer-term radon measuring detectors provide truer indications of annual average radon concentrations in the

---

When the testing and re-testing results have been determined, the owner of a house with radiation levels that require action should contact the state radiation office for advice about which measures are needed to reduce the home's radon levels, which of those measures can be done by the homeowner alone, and which will need to be done by a trained professional.

Short-Term Actions to Reduce Radon Exposure

Certain steps can be taken even while more long-term radon-reduction measures are considered. Here are some actions that home over a period of time. Somewhat more expensive than the short-term charcoal canisters, these radon test kits are exposed for three months to a year and generally are viewed as providing the most reliable and most representative measurements of annual average radon levels in a home.

The alpha track kits, for instance, feature a piece of special plastic in a filtered container. Alpha particles emitted by radon gas "track" the plastic, leaving small tracks or scars which later are counted by a laboratory as an indicator of radon concentration. Continuous radon measurement devices, integrated radon sampling units, grab sampling instruments, and charcoal liquid scintillation cells also can be used, though they typically require a trained operator for them to be used effectively. Passive radon monitors using a charged electret to react with radiation from radon or radon gas can be used for either short- or long-term tests.

Neither the charcoal canister nor the alpha track kit is particularly difficult to use, and both can be returned by mail for analysis. Both are considered "passive" tools, in that they require no external power but rather are merely placed in an appropriate test location.

Both charcoal canister and alpha track radon test kits can be purchased at many hardware, grocery, and home supply stores throughout the country. Some state and local governments also supply radon detectors to residents, and newspaper and TV/radio audiences can be referred to state radiation protection offices for information about availability of testing kits in their areas.

Many reporters find that information on selection, use, and interpretation of radon test kits make effective sidebars for hard-news stories on radon risks.

---

homeowners can take to reduce radon risks to themselves and their families:

- If possible, spend less time in areas where radon levels are highest, such as the basement.

- Stop smoking and discourage smoking in the home. Smoking may increase the risk of exposure to radon, in addition to increasing overall chances of getting lung cancer.

- As often as practical, open windows throughout the house and turn on fans to increase the air flow *into* and through the house, especially in the basement.

Long-Term Actions to Reduce Radon Exposure

For homes with higher radon concentrations, radon officials recommend, along with the above, more thorough actions to reduce those levels -- actions which either reduce the rate at which radon enters the house, or forces the radon out of the house once it has entered.

Reducing the rate of radon entering the house can be accomplished either by blocking off or sealing the places in which it enters, or by reversing the direction of the flow of these pathways so the indoor air and radon is pushed out, rather than brought into the house. The best way to force radon out of the house is to increase ventilation.

A contractor who specializes in ridding homes of radon should be hired for the more complex remedies. These contractors in general are not the same firms that produce radon detectors. EPA regional offices, state radon offices, Better Business Bureaus, and local consumer affairs departments should have lists of radon contractors.

Long-term methods to reduce radon levels, and their approximate repair costs, include:

Sub-slab suction by installing pipes and fans to pull radon from under the slab foundation is generally considered the most effective radon reduction technique. The same approach can be taken with drains and/or block walls. A trained professional should install the system.

Sealing major radon sources and entry points involves covering exposed earth in basements, storage areas, drains, and crawl spaces with impermeable materials, such as plastic sheet metal, and sealing cracks and openings with mortar or urethane foam. This step generally is considered most effective when taken in combination with other radon-reduction efforts. Advice on identifying areas to seal should come from an experienced professional, who may have to do some of the work.

Forced cross-ventilating, by using fans on both sides of the house.

Heat-recovery ventilating, suitable in homes that need heating for several months of the year. A heat-recovery ventilator or "air-to-air heat exchanger" has a pair of fans to blow stale air out the house and draw in fresh air. They also reclaim some of the heat the furnace generates while maintaining the adequate ventilation needed to reduce the home's radon. Installation and annual operating costs will vary widely throughout the country.

Adjusting air pressure within the house by providing air from outside to appliances that would otherwise use air in the house for combustion. By providing appliances such as the furnace, fireplace, and clothes dryer with external sources of air, the air pressure inside the house is increased, reducing the amount of radon drawn up into the house. This work must be done by an experienced professional, and the costs will vary according to the difficulty of venting each appliance.

Important Questions

Effective and accurate news reporting about radon requires a proper balance of urgency, information and reassurance. It is important for homeowners to know that radon is a serious environmental health threat. But it is just as important for them to know that radon is a manageable threat that can be handled by individuals who are educated about how to determine their risk from radon, and how to remedy that risk.

Questions to consider when preparing stories on radon include some obvious ones: How serious is the radon threat locally? Have residents been testing for radon? What are they finding? How soon should additional testing be done?

But some questions to consider will require more thoughtful reporting:

> How can homeowners be informed about radon without being scared off by the specter of lung cancer -- and therefore never testing their homes?
>
> Why do homeowners not test -- for logistical, financial, or emotional reasons? Is there a rationale to their non-testing? Or is it something they "just haven't gotten around to yet"?
>
> Are there reliable and certified contractors in the state to implement the needed long-term methods to reduce high levels of radon -- and is it easy to find them? Do local universities and laboratories have radon experts available to answer questions?
>
> Has EPA, the state, or anyone else done residential or school testing? How extensive was the testing? What were the results? Have schools undertaken radon-reduction activities?

Chapter 3

Reporting on Radon: Should Radon's Differences Make it LESS Newsworthy?

Summary

- *Radon challenges some fundamental assumptions of journalism in answering the riddle: "What is news?" For journalists, radon poses intriguing challenges to conventional attitudes on environmental health reporting.*

- *With no clear "villains" and no "victims," this invisible and odorless pollutant proves an elusive target, but its status as the nation's second leading cause of lung cancer makes it an important public health issue of interest to households throughout the country.*

- *Radon may be the exception that proves the rule, but like other issues that make good news, it requires extra effort. The "bad news" in the radon story is that radon causes thousands of unnecessary lung cancer deaths each year in the U.S. and that available steps to avoid future deaths are being ignored in many quarters. The "good news" is that radon reduction techniques are readily available and generally economical.*

- *An extensive body of scientific evidence from Central Europe and from underground mining activities provides human data on radon's health effects. As a result, scientists are "considerably more certain of the risk estimates for radon" than they are for risk estimates based solely or primarily on animal tests.*

Chapter 3

Reporting on Radon: Should Radon's Differences Make It LESS Newsworthy?

Radon doesn't fit the usual mold.

For journalists, one might think that would make it inherently interesting, man bites dog and all that.

But it doesn't seem to work that way. In fact, one could argue that the very things that make radon and its associated health effects different from other environmental problems also make them somehow *less* newsworthy. Particularly given the health risks associated with radon exposures, it's a situation that should give environmental journalists pause.

Consider some of the factors that set radon apart from other environmental pollutants.

For one, radon is a radioactive gas which occurs naturally as a result of the radioactive breakdown, or decay, of uranium and radium in the soil. That means there is not the usual "villain" associated with putting the pollutant there in the first place. It also means there is no identifiable "deep pockets" on which to fix blame or assess penalties, no institutional greed that might be tied to some variation of midnight dumping.

The pernicious effects of prolonged radon exposures are well-documented, documented in fact through extensive radiation and human health studies, and not dependent on ambiguous extrapolations from rats or mice to humans. At the same time, the effects -- specifically the increased chances of incurring lung cancer -- are manifested only after prolonged exposures and after long latency periods. Radon-induced lung cancers don't appear over night, but rather over time.

That means there is a lot of time, and a lot of complex variables, before radon-induced lung cancers take hold.

Radon is different in other ways that set it sharply at odds with the conventional environmental health problems symbolized, for example, by an oozing 55-gallon drum. Unlike the pervasive effects of urban smog or contaminated aquifers, radon poses personal risks which individuals themselves can reliably detect and measure. If you are at risk of increased lung cancer in your home because of excessive radon concentrations, it's not terribly hard for you . . . or your readers or viewers . . . to find that out. Measuring radon concentrations in one's living environment and then determining, based on those measurements, whether the associated risks are "acceptable" is something within the reach of pretty much all of us.

It's not terribly expensive, and not at all time-consuming or complex. For $10 or so, most of us can get an early indication of whether our homes might harbor radon concentrations that would justify further analysis or, possibly, fix-up efforts. The situation stands in stark contrast to the kinds of enormous societal costs associated, for instance, with clean-up of hazardous waste sites or with meeting health-based air quality standards in smog-ridden urban areas.

Humans can't taste, smell, or see radon, but this isn't one of those cases where what you don't know can't hurt you. It can. In fact, as discussed earlier, radon exposures account for more incidences of lung cancer than any other cause except cigarette

Testing for Radon

Two interesting characteristics of radon set it apart from other environmental health risks:

. . . individuals in most cases can easily test their own home environments to establish the level of radon risk they may face; and

. . . once concerned that they face unacceptable risks, individuals in most cases can move effectively to reduce those radon risks, and they usually can do so without incurring exorbitant costs and without making changes in their own lifestyle.

In effect, radon is a risk that your readers and listeners can evaluate as it applies to them specifically. And it is one they can reduce on their own if they choose to.

---

smoking, according to the U.S. Surgeon General's office. Given that lung cancers have an overall fatality rate of 54.1/100,000 population, the public health benefits of reducing radon exposures are clear.

While the risks posed by high radon concentrations constitute the "bad news," the "good news" lies in the fact that those risks can be controlled -- controlled without imposing huge costs or life-style changes along the lines of reducing personal car use or shifting to alternative fuel supplies.

The media come in for their share of criticism for "loving villains." And there's no question that a good villain can make for good news copy.

At the same time, however, the public and the media also love a good hero. What makes the radon story so enticing and so juicy from a reporter's standpoint is not only that it involves a significant public health issue -- "one of today's most serious public health issues," according to Dr. Vernon J. Houk, Assistant Surgeon General of the U.S. Public Health Service -- but also that the individual risks are manageable and controllable, once the risk is detected.

Another important element in a good story is evidence. In the case of radon-induced lung cancers, the scientific evidence is as strong as any in the environmental health field. "From all the evidence, radon in the home is the most deadly environmental hazard in America today," says Robert E. Yuhnke, a radon specialist with the Environmental Defense Fund (EDF), a national environmental organization.

Evidence? What evidence? It turns out that as long ago as the sixteenth century, radon-induced lung cancers are believed to have plagued miners in Central Europe. Notwithstanding some uncertainty about the precise levels of health risk posed by different radon concentrations and exposures, public health specialists point out that radon risk estimates are based on scientific studies of human beings exposed to radon in their underground mining jobs. That obviates the need to rely on frequently more uncertain extrapolations from animal tests, although such tests only reinforce concerns raised from human data.

In the case of radon, more research over time has led to more consensus. Studies done by the U.S. Public Health Service in the 1960s pointed to a strong correlation between lung cancer and American underground workers exposed at high radon levels. American miners exposed to lower radon exposures suffered less lung cancer.

Based on studies of survivors of the Hiroshima and Nagasaki atom bombs and of British patients x-rayed extensively for arthritis of the spine, it is clear that radiation produces lung cancer. "It was not a simple matter to relate these exposures to those from radon, but this has now been done," Consumers Union says in *Radon*.

Writing in that book, University of Pittsburgh physics professor Bernard L. Cohen explains that "for good geochemical reasons," uranium and coal do not occur together. Coal mines therefore have very little radon. They do, however, have diesel fumes, dust, and other possible sources of lung cancer. "Coal miners have high rates of nearly every respiratory disease, including bronchitis, pneumoconiosis, and pneumonia. At one time it was thought that they also suffered a high rate of lung cancer, but more careful studies have shown conclusively that lung cancer incidence among coal miners is very close to the national average. This confirms that radon, and not chemical agents, is very probably the culprit that causes lung cancer in uranium miners."

With the radon risk estimates based on scientific studies of miners, "scientists are considerably more certain of the risk estimates for radon than they are of those risk estimates which rely solely on studies of animals," the U.S. Environmental Protection Agency concludes in "A Citizen's Guide to Radon: What It Is and What To Do About It."

Studies of sixteenth-century silver miners in the Erz Mountains separating East Germany and Bohemia (now Czechoslovakia) demonstrate that radon-induced lung cancers are not just a "new" problem. But residential radon became a significant concern only when Swedish scientists in the 1970s found unusually high radon levels in recently built homes. Builders were using concrete with high radium levels. Further investigations identified more homes with high radon concentrations resulting from naturally occurring radon in the soil.

In the western U.S., says the Environmental Defense Fund, high radon levels were traced to construction materials contaminated by uranium mill wastes. Those ended up being the proverbial tip of the iceberg, as homes throughout the U.S. -- many far from uranium mining areas -- are believed to be receptacles for naturally occurring radon.

"Ten years ago, no one imagined that such high levels of radon would be found in so many homes throughout the country," EDF says.

Chapter 4

Disputing the Radon Risks

Summary

- *Like other environmental health risks, radon is not without controversy. But the debates over radon generally concern how much of a cancer risk high radon concentrations pose, not whether there is a risk in the first place.*

- *The availability of human data based on studies of underground miners gives scientists more confidence in the radon risk estimates. Not having to rely solely or primarily on animal studies extrapolated to humans, policy makers feel more comfortable in relying on radon risk estimates.*

- *In the scheme of human health risks, radon ranks high among the environmental risks. People should no sooner ignore radon risks than they would other "routine" risks which they regularly seek to control or minimize.*

- *The U.S. EPA and the Office of the Surgeon General recommend screening tests for all houses for radon concentrations. Critics of that approach favor a targeting of suspected high-radon-risk homes, but the difficulty of making such predictions -- and the relative ease of testing in the first place -- convince EPA that universal testing is a prudent and effective preventive strategy.*

- *The 4 pCi/l action guideline represents results from screening tests designed to give an early indication of a potential radon concentration problem. Many scientists feel there is no absolutely safe level of radiation exposure, and they argue for reducing unnecessary exposures when possible.*

Chapter 4

Disputing the Radon Risks

If you think you have never met an environmental issue without controversy, and then along came radon . . .

. . . think again.

The radon issue too has its controversy, though the debate tends to involve *not whether* high radon readings pose a public health risk, but rather *how much* of a risk they pose, and under what conditions.

Quantifying Chronic Health Risks

Quantifying chronic risks from low-level hazards is notoriously imprecise. And in a field fraught with uncertainties, the range of disagreement over radon's health effects is relatively small. For many chemical hazards, risk estimates disagree by 100-fold or more. For dioxin, for instance, the range is more than 1,000-fold.

Why the uncertainty? Because for most hazardous substances it is hard to get good data on humans. Few people have been exposed for decades to known amounts of most hazardous materials, and humans cannot be used as guinea pigs. Instead, the hazard per dose is usually estimated from tests on laboratory animals. Typically, this requires extrapolation that stretches science to its limits. When laboratory mice develop nasal tumors after breathing formaldehyde vapors throughout their short lives, scientists try to deduce how a human would react to barely detectable levels of the stuff. Credible scientists can employ a variety of different assumptions in these calculations -- with widely varying results.

"Scientists are considerably more certain of the risk estimates for radon than they are of those risk estimates which rely solely on studies of animals," the EPA concludes in its pamphlet, "A Citizen's Guide to Radon: What It Is and What to Do About It." Although available animal studies support the human data indicating health risks from radon exposures, it is the availability and extent of the human data that underlies the strength of the radon risk estimates.

Sheldon Krimsky and Alonzo Plough -- two Tufts University Center for Environmental Management professors who wrote *Environmental Hazards: Communicating Risks as a Social Process* -- agree. "Risk assessments for radon exposure carry a greater certainty than those for many other exposures, because extensive research has been done on the biological effects of radiation," they say.

Estimating the Number of Lung Cancer Deaths

There is controversy over the number of lung cancer cases attributable each year to radon. EPA estimates that some 20,000 lung cancer deaths in the U.S. each year are attributable to radon exposures.

The agency uses the risk-per-unit-of-exposure assumption developed by the National Academy of Sciences' Committee on Biological Effects of Ionizing Radiation (BEIR). However, that group itself made no estimate of the number of annual lung cancer deaths because it believes no definitive data on indoor radon exposures are available. The National Council on Radiation

Protection and Measurements (NCRP) -- a congressionally chartered nongovernmental public service organization charged with advising on radiation protection measures -- in 1984 estimated 9,000 annual deaths attributable to radon-induced lung cancers. It has not made a more recent estimate of radon-induced lung cancer deaths. While less than EPA's current estimate of some 20,000 lung cancer deaths annually because of radon, that range of estimates is considered normal in health risk assessments.

Even proponents of lower radon risk-estimates concede that radon risks are far higher than those associated with most environmental health hazards regulated by EPA. The agency calculates that lifetime exposure to average home radon levels (about 1.5 pCi/l) will cause lung cancer in about 3 percent of the population. Radiation researchers Dr. Jonathan M. Samet, with the University of New Mexico Medical Center, and Anthony V. Nero, Ph.D., a physicist at the University of California, Berkeley, see the risk as only one-third that high or less. Nonetheless, they write that, "For average Americans living in houses with an average radon concentration, the lifetime risk is projected to range . . . far higher than the estimated risk for most carcinogenic pollutants that are regulated in outdoor air."

A February 1987 EPA staff report, "Unfinished Business: A Comparative Assessment of Environmental Problems," for instance, concluded, based on staff's "professional judgment rather than on quantitative methods," that indoor radon and worker exposures to chemicals rank highest in terms of potential cancer risks. That group of EPA professional civil servants cited agency data indicating that radon-induced lung cancers greatly outnumbered annual cancer cases caused by 20 different toxic air pollutants.

Fretting over 'Routine' Risks?

Physicist and radon expert Anthony Nero agrees with the characterization of radon as "an important environmental problem" and one that poses risks "larger than risks that the EPA normally regulates." However, Nero contends that the risk of even high radon concentrations may nonetheless be tolerable to many people.* He has argued, for instance, "while the public routinely

**Unpublished letter to the Environmental Health Center outlining Dr. Nero's views of "the important radon issues," June 1989.*

copes with risks at this level in their personal environments, the EPA has difficulty. It may be frustration with public inattention that has led the EPA to exaggerate the problem so greatly despite frequent cautions from the scientific community."*

"The fact is that the estimated risks from radon -- even at EPA's remedial action guideline of four picocuries -- are no larger than the observable risks that we routinely accept by living in homes or using our cars or working at our jobs," Nero wrote to the Environmental Health Center in June 1989. "In these places, where we really spend our time, we encounter risks that have about a 1 percent chance of eventually causing our deaths. In contrast, the EPA, in regulating the extent to which industry or cars pollute the atmosphere or water resources, rightly limits risks to much lower levels, even as low as one in a million (instead of one in a hundred). Considering these contrasts means we have to develop a practical perspective on risks in the indoor environment, not simply try to fit into the mold that is appropriate for regulatory matters."**

EPA Director of Radiation Programs, Richard J. Guimond, is not convinced by Nero's point that radon risks parallel those "routinely accepted" by people. Guimond, in a June seminar for journalists that EHC sponsored as part of this project, countered that individuals in their homes and cars routinely take steps to reduce even "routine" risks. They install banisters on stairways, use seat belts, and install slip-proof stickers in showers and baths to prevent falls. Guimond says people don't generally ignore "routine" risks, and he thinks they shouldn't ignore radon risks either, given that testing is reliable and generally inexpensive.

Target Worst Radon Homes First?

Nero, widely recognized as a responsible critic of EPA on radon issues and one not prone to an "extreme" radiation-is-good-for-you position, points to estimates that perhaps 50,000 to 100,000 U.S. homes have radon concentrations exceeding 20 picocuries per liter of air. "Addressing the problem in these

**Unpublished article entitled "Radon Hysteria," by Anthony V. Nero, Jr.*
***Unpublished letter to the Environmental Health Center outlining Dr. Nero's views of "the important radon issues," June 1989.*

homes should occur first, and it will permit us to better understand the issue of risk at lower levels," he writes. "Ironically, the EPA, because of its screening protocol, *overestimates* the number of such houses by about a factor of ten *and* says that they deserve *immediate follow-up*, but still has not focussed its programs to find them, even though it is now *more than a decade* since we realized such houses occurred in significant numbers."*

On that point, Guimond counters that the agency for a period of years in the early 1980s attempted to target those houses likely to have the highest radon readings. But with no scientific ability to reliably target hot-spot areas, and with houses within single neighborhoods having widely different radon readings, he says the approach is unworkable.

Risks for Smokers vs. Nonsmokers

Another aspect of EPA's radon approach that annoys critics such as Nero is the agency's equating radon levels with numbers of cigarettes smoked. The agency often has said, for instance, that being exposed to a radon concentration of four picocuries per liter of air over a lifetime exposure of 70 years raises the lung cancer risk to that of a person who smokes half a pack of cigarettes a day.

"Often the risk from radon -- e.g., at the EPA guideline -- is compared in inappropriate ways with smoking, exaggerating the level of risk," Nero writes. "This is truly ironic since the risks usually cited don't even apply to most people, but only to smokers! We really need a better way of conveying information on risk, just as we need to focus efforts that genuinely cause high exposures and risks."**

Some critics suggest that EPA's averaged risk estimates for all exposed individuals distort the risks for non-smokers because the risks from radon are so much higher for smokers. Many scientists believe that smoking doesn't just add to the risk from radon, it multiplies it.

**Unpublished letter to the Environmental Health Center outlining Dr. Nero's views of "the important radon issues," June 1989.*
***See note above.*

Dispelling Popular Misconceptions

Reporters can help dispel some of the popular myths that researchers say surround the radon issue. For instance:

Some people believe that radon builds incessantly up over time and that repairs therefore get increasingly difficult and expensive. In fact, once paths of entry into a home are closed, the risk is reduced.

Some people believe that radon contamination in their home can lead to radiation contamination of other things, such as carpets, furniture and utensils. They fear that finding high radon concentrations may force them to replace household goods. Such fear prevents some people from testing in the first place. There's absolutely no basis for these concerns.

Other people believe that radon is isolated to relatively few geographical "hot spots." In fact, naturally occurring radon is ubiquitous, and high concentrations have been found throughout most of the country.

Some people take mistaken comfort in learning that a neighbor's house or neighbors' houses have had low radon readings. In fact, a low radon reading right next door does not necessarily guarantee a low reading in one's own home. On the other hand, the incidence of numerous high radon readings in a community should heighten a homeowner's commitment to individual testing.

"The risk of lung cancer for a smoker compared with a nonsmoker is increased approximately ten-fold on average but reaches twenty-fold or higher in heavier smokers," writes Dr. Samet. Most experts contend that exposure risks for non-smokers are sharply lower than EPA calculations suggest. "I'm not sure public policy should be based on what the risk to the smoker is," says William Mills, a former EPA official who is senior technical advisor for Oak Ridge Associated Universities in Washington, D.C.

EPA public health experts say that nonsmokers are just as entitled to protection against incrementally smaller increases in lung cancer risks as smokers are to the larger increased risks that can result from the combination of smoking and high radon concentrations. They point out, for instance, that nonsmokers generally tend to be somewhat more risk-averse overall than smokers. They say that nonsmokers therefore may feel more strongly about avoiding smaller increased health risks than smokers do about accepting incrementally larger increases in health risks.

Some people believe that radon poses no particular public health risk to non-smokers, but rather only to smokers. The fact is that smokers are especially at risk from high radon concentrations because the increased particulates in the air provide radon a free ride into sensitive lung areas. But nonsmokers also are at increased risk of incurring lung cancer from radon. One thing for sure: High radon concentrations and smoking are a risky combination.

Some people take a "Why test?" approach to radon. Considering that the costs of radon testing compare with the costs of installing smoke alarms -- another common preventive health care tool -- perhaps a "Why not test?" attitude makes more sense in most cases.

As with all health risks, some people adopt an "It can't happen to me" approach to radon. But it can. Those people might not think twice before wearing seat belts or installing a banister down the basement steps. Why not take similar precautions in reducing a risk which could lead to their developing lung cancer down the road?

Do some people think they can tell whether their home has unusual radon concentrations without first testing for radon? Apparently. Scientists say there's no way: Testing is the only way of knowing what one's radon level is.

Furthermore, EPA officials point out that legislation covering public health issues often calls for protection of "sensitive populations," that is population groups with particular vulnerabilities to environmental insults. If those population groups in the case of radon include smokers, one might ask, shouldn't public policy be aimed at protecting those sensitive groups?

Is EPA Being Overly Cautious?

Nero is not alone in his criticisms of EPA for its handling of the radon risk issue. Some of the most stinging criticisms have come from physics professor Bernard L. Cohen, of the University of Pittsburgh. Cohen says he thinks the agency is being overly cautious in recommending possible renovation of radon problems in millions of U.S. homes which, he says, do not need their actual radon levels reduced.

Cohen thinks radon public policy should not be premised on an assumption that there is no radiation threshold below which no danger exists. In effect, Cohen is raising the issue of whether there exists a threshold below which exposure to radiation poses *no* risk.

"There doesn't seem to be any doubt that radon is by far the most dangerous radiation danger most of us face," Cohen told the American Chemical Society's annual meeting in September 1988. "But if it turns out that radon is harmless below a certain level, then we should probably stop worrying about the very much lower risks created by fallout from the Chernobyl reactor accident, medical x-rays, reactor gas leaks, and so on."

The point here is a critical one. Note the phrase: " . . . if it turns out that radon is harmless below a certain level . . . ." The issue here is whether one can assume, from the standpoint of public safety, a threshold below which radiation exposures present no risk to human health. The accepted approach with many carcinogens, for instance, is to assume no threshold below which exposure will not lead to an increased risk of cancer. Many scientists apply this same zero-risk threshold philosophy also to radioactivity. The issue of whether a threshold exists for radioactivity is one likely to remain unresolved for years to come, and perhaps indefinitely, as scientists and public health policy officials seek to address uncertainties.

. . . Or is the Agency Leaving People at Risk?

While EPA has its radon critics who contend that the agency is over-estimating risks, it likewise has critics who say it is doing too little to protect against radon-induced lung cancers. In its citizens' guide to radon, for instance, the Environmental Defense Fund says "cancer specialists believe that there is *no known safe level* of exposure to radon or any other cancer-causing agent. Rather, there is a dose/disease relationship, wherein even the smallest exposure adds to the risk of disease."*

*Radon: The Citizens' Guide, *Environmental Defense Fund, 1987.*

EPA "recommends that remedial action be taken to reduce exposure *only* when radon concentrations exceed 4 pCi/l," EDF writes, arguing that such an approach in effect tells the public that a 4 pCi/l level is "safe."

"The Environmental Defense Fund believes that the cancer threat at 4 pCi/l is much too high, and that EPA is misleading the public into believing that dangerously high levels of radon exposure are safe. ***The EPA standard is not safe.***" (emphases in original)

Radon Story Ideas . . .

Radon is a great first-day story, but some reporters find it challenging to find good follow-ups. Here are some ideas:

- Tap into state radiation, radon, and public health agencies to try to identify local radon "hot spots."

- Have local schools tested for radon, as recommended by the federal government? If so, what have they found? Have they found high radon concentrations but, for whatever reasons, chosen not to make repairs? Why?

- Consider having your newspaper or TV/radio station conduct its own short-term tests at particular sites in your community.

- How is business for local radon remediation firms? How do citizens choose reputable companies? How much do repairs cost in your community?

- Most homeowners aren't testing for radon -- ask several dozen local residents why. Do they wear auto seat belts and pre-wash their vegetables prior to cooking them? Are they smoking, rock-climbing, sky-diving adventurers in pursuit of risk? Are they aware of radon risks? Do they care?

- Profile a radon-reduction contractor. What is that contractor's "day in the life"?

- Fraud watch: Are con artists promoting radon tests in your community with mayonnaise jars and fly-by-night fixups?

- Real estate: What are agents and brokers doing in your community when it comes to property sales? Are radon contingency clauses being added to home sale contracts? Are developers adopting radon-proofing measures in their new buildings?

- Check your local area to see if schools are teaching radon testing and reduction procedures. (U.S. EPA sponsors some such schools throughout the country, for instance.)

- Profile a homeowner who has tested a residence and made improvements to reduce radon risks. Interview the neighbors.

Radon Questions and Answers

What is radon?

Radon is a colorless and odorless radioactive gas that occurs naturally in rocks and soils and in underground water supplies and outdoor air. It occurs at varying levels throughout the U.S.

Does radon pose health risks only in select geographical "hot spots"?

That was once thought to be the case, based on high uranium concentrations in former mining sites. In the mid-1980s, however, it became clear that naturally occurring radon also posed significant public health risks, and that the risks exist far and wide, well beyond recognized "hot spots" such as the Reading Prong in Pennsylvania, New Jersey, and New York. The effect of this realization was to transform the radon issue immediately into a national problem, one requiring a coordinated national approach.

Are the health risks posed by natural radon any more or less serious than those posed by radon resulting from activities such as underground mining?

The human body doesn't distinguish between natural and technological, or anthropomorphic, radiation. A dose of one has the same effect as an equal dose of the other. The real public health significance is that potentially harmful concentrations of naturally occurring radon are ubiquitous: Radon levels comparable to those found in underground mines have been reported in residences in the U.S. Preventive health care strategies must confront the radon issue on that basis.

What does EPA mean when it refers to a "screening measurement"?

EPA has recommended that individuals living below the third floor of buildings conduct short-term radon tests so they will have a "screening measurement" that provides an indication of the highest radon level likely to be found in their home. A radon screening level above the four-picocurie-per-liter guideline suggests more extensive follow-up measurements are desirable. Below that level, the individual is less likely to find an annual average radon concentration that would warrant concern or immediate follow-up actions.

Radon is identified as the second leading cause of lung cancers, behind smoking. Are there other health effects identified with radon exposures?

An increased risk of developing lung cancer is the only known health effect associated with exposures to elevated radon levels. Generally fatal, lung cancer is the fastest-growing cause of cancer deaths in the U.S.

What exactly is meant when people refer to radon's "daughters"?

When radioactive materials decay, they give birth to new radionuclides. Radon is one of the offspring of uranium, through a series of decay processes that occur over thousands of years. But radon is not the last step in that decay process. As radon itself decays, it gives rise to its own "daughters" (also referred to as "progeny" or "decay products"). The radon decay products of greatest concern from the standpoint of lung cancer are polonium-214 and -218, because these decay in the lungs and emit alpha particles which can damage genetic materials (DNA) in the cells.

Is the federal government recommending that all residences in the United States test for radon, even where there are no signs of high concentrations in a neighborhood?

Precisely because one cannot predict whether a particular residence in a neighborhood will have a high radon concentration, EPA has suggested that most homeowners should test for radon. Reliable and economical testing procedures make such tests a sound insurance policy for homeowners wanting to manage their own potential cancer risks.

Is a concentration of four picocuries per liter of air "safe"? Is five picocuries and more considered unsafe?

It just isn't that simple. The concept of "safety" is relevant, and some individuals will feel comfortable with their cancer risks at a level that would make others uncomfortable. The "beauty" of the radon issue -- and what distinguishes it from so many other environmental health issues -- is that individuals can detect and control their own cancer risks. There are proponents of both a higher and a lower radon action level, but the government's public health experts recommend reducing radon levels as much as is practical. EPA believes most homeowners will find it practical to reduce radon to less than four picocuries per liter of air.

Isn't it unrealistic for EPA's risk assessments to assume exposures at radon concentrations over a 70-year life span?

EPA's risk estimates assume a person will be exposed to the radon level found in the home for roughly 70 years and that the individual will spend 75 percent of his or her time in the home. Persons should take those assumptions into consideration in assessing their personal risks, keeping in mind that former or future residences may have lower, comparable or higher radon levels than those found in the current home.

Is EPA attempting to impose radon testing and removal costs on the non-smoking population based on risk figures that apply more accurately to smokers?

Both smokers and nonsmokers are at increased risk of contracting lung cancer as a result of prolonged exposures to elevated radon levels. Stopping smoking and discouraging smoking in homes with elevated radon levels will help reduce a family's overall chance of contracting lung cancer. Because many nonsmokers are more "risk-averse" than smokers overall, nonsmokers frequently want to protect themselves against the incrementally smaller increased risks of developing lung cancer.

Given that EPA's own radon risk assessments are based on 70-year exposures, why is the agency concerned about risk exposures in schools, where exposure durations certainly will be much shorter?

Preliminary EPA screening test data from 130 schools nationwide indicate that elevated radon levels in schools may be at least as common as in private residences. Children are more sensitive to radon exposures than adults, because their lungs are smaller and they frequently breathe in and out more rapidly. In addition, children have a higher cumulative risk over time. For these reasons, EPA's radon guidance takes a "more cautious approach" for schools than for private residences.

How do health risks posed by radon exposures compare with other environmental health risks regulated by EPA?

Even in the lower end of various estimates of annual lung cancer deaths in the U.S., radon exposures account for more fatalities than other environmental pollutants overseen by EPA.

Does the presence of neighboring houses with high radon concentrations mean that a nearby house also will have high readings? Do low radon concentrations throughout the neighborhood mean a house will likely not *have a problem?*

Having a neighbor whose house tested below four pCi/l for radon is no guarantee that your house will test similarly. Differences in pathways under the house and through the foundation make such assumptions inappropriate. On the other hand, a concentration of high radon readings in the neighborhood should prompt homeowners to move more expeditiously on testing their own homes. In that case too, however, high readings in a neighboring home do not necessarily mean a separate home also will test high.

What are the scientific bases for the lung cancer concerns which the Environmental Protection Agency and the Office of the Surgeon General attribute to radon exposures?

As with all pollutants, there is some uncertainty in estimating health risks associated with radon. On the other hand, radon risk estimates are based on scientific studies of miners exposed to different levels of radon in their underground work. Because the risk estimates do not have to be extrapolated from animal tests, scientists are considerably more certain of radon risk estimates than they are of estimates based solely on animal studies. In the case of radon, available animal tests substantiate the human health data indicating increased incidences of lung cancers as a result of radon exposures.

Does radon pose particular health risks for the elderly?

The long latency period for the onset of lung cancer generally exceeds the life expectancy of an elderly person in any event. At the same time, high radon concentrations would remain a concern for other family members in the home.

Aren't radon testing kits inaccurote? And don't they therefore give inaccurate radon risk readings?

The precise accuracy of radon test kits should not pose significant concerns for individuals fearful of exposure to elevated radon levels. Responsible test kits, when used as directed, provide reliable indications of radon concentrations over the time the kits are used.

When should short-term screening tests be conducted? Does time of year matter?

Winter screening tests are most effective because the larger differential between outdoor and indoor pressure is likely to lead to higher entry of radon into a house than would occur when indoor and outdoor temperatures are closer. Because screening tests are designed to indicate potential peak concentrations, cold-weather readings are generally preferable to summer screening measurements. At the same time, it is important to emphasize that a reading during any one season of the year will provide a measure for just that season, and not for a full year. Short-term readings are most helpful when complemented by long-term readings. This issue is of particular importance in real estate transactions, given the large number of home sales conducted in summer months, when short-term readings might lead to inconclusive results. Summer radon readings typically are lower than those taken in the winter.

Should I sell my house if it has a high radon concentration? Should I refuse to buy a new house with a radon problem?

Would you sell your house because it doesn't currently have smoke alarms? Or because it needs new roofing? Would you refuse to buy a new home based solely on those criteria? Again: the "beauty" of the dilemma we face with radon is that the problem, if there is one for a particular residence, is eminently fixable, and usually for fairly reasonable costs.

Why should I spend more for a long-term test that takes a longer time before giving me results than I would for a short-term test, which not only costs less but which also provides results within a week of start-up?

The long-term radon test kits take into consideration seasonal variations, which can be substantial. The less expensive short-term kits provide an excellent indicator of whether a more expensive long-term test will be warranted, but the short-term kits are no substitute for a long-term measurement in those instances where elevated readings are indicated on the short-term test. Unless an extremely elevated level were found by the screening measurement -- for instance, a level of 200 pCi/l -- quick confirmatory measurements would be a prudent next step.

What radon testing device will give me the most reliable results?

Most radon test kits are accurate and reliable for the purposes for which they are marketed. However, because long-term average exposures are important, the long-term measurement devices provide the most reliable radon readings economically available.

What steps might be taken to prevent development of a radon problem in new homes?

A number of cost-effective steps can be taken in new home construction to help ensure against elevated radon concentrations. Sealing basement foundations and cinder block walls and junctures between the slab and the walls will help prevent radon from entering into homes. Additional information on this subject is available from EPA's *Radon Reduction Methods: A Homeowner's Guide*, available from state radiation protection offices and from EPA regional offices. In addition, EPA and the National Association of Home Builders Research Foundation, Inc., have collaborated on publication of *Radon Reduction in New Construction: An Interim Guide*. The report (OPA-87-009, August 1987) is available from the EPA Office of Air and Radiation in Washington, D.C.

Is radon a problem in drinking water supplies, or only in household air?

Radon can enter water and be released into residences when faucets are turned on or when appliances such as washers are used. Generally, radon is less of a concern with public drinking water systems, where the radon likely is released to outdoor air before reaching the home faucets. EPA is working to develop a drinking water standard to set a maximum contaminant level for radon.

Sources of Information

EPA Regional Offices

617/565-3231 Region 1 *(Office located in Boston MA)*

Connecticut
Maine
Massachusetts
New Hampshire
Rhode Island
Vermont

212/264-2515 Region 2 *(Office located in New York NY)*

New Jersey
New York

215/597-8320 Region 3 *(Office located in Philadelphia PA)*

Delaware
District of Columbia
Maryland
Pennsylvania
Virginia
West Virginia

404/347-3907 Region 4 *(Office located in Atlanta GA)*

Alabama
Florida
Georgia
Kentucky
Mississippi
North Carolina
South Carolina

312/353-2205 Region 5 *(Office located in Chicago IL)*

Illinois

	Indiana Michigan Minnesota Ohio Wisconsin
214/655-7208	Region 6 *(Office located in Dallas TX)*
	Arkansas Louisiana New Mexico Oklahoma Texas
913/236-2893	Region 7 *(Office located in Kansas City KS)*
	Iowa Kansas Missouri Nebraska
303/293-1709	Region 8 *(Office located in Denver CO)*
	Colorado Montana North Dakota South Dakota Utah Wyoming
415/744-1530	Region 9 *(Office located in San Francisco CA)*
	Arizona California Hawaii Nevada
206/442-7660	Region 10 *(Office located in Seattle WA)*
	Alaska Idaho Oregon Washington

State Agencies Providing Radon Information

205/261-5315	Alabama
907/465-3019	Alaska

602/255-4845	Arizona
501/661-2301	Arkansas
415/540-2134	California
303/331-4812	Colorado
203/566-3122	Connecticut
302/736-4731	Delaware *(or 800/554-4636)*
202/727-7728	District of Columbia
904/488-1525	Florida *(or 800/543-8279 for consumer inquiries only)*
404/894-6644	Georgia
808/548-4383	Hawaii
208/334-5927	Idaho
217/786-6384	Illinois *(or 217/786-6399 for publications)*
317/638-0153	Indiana *(or 800/272-9723 in state)*
515/281-7781	Iowa
913/296-1560	Kansas
502/564-3700	Kentucky
504/925-4518	Louisiana
207/289-3826	Maine
301/631-3300	Maryland *(or 800/872-3666)*
413/586-7525	Massachusetts *(or in Boston, 617/727-6214)*
517/335-8190	Michigan
612/623-5348	Minnesota
601/354-6657	Mississippi
314/751-6083	Missouri *(or 800/669-7236 in state)*
406/444-3671	Montana
402/471-2168	Nebraska
702/885-5394	Nevada
603/271-4674	New Hampshire
609/987-6402	New Jersey *(or 800/648-0394 in state)*
505/827-2940	New Mexico
518/458-6450	New York *(or 800/458-1158 in state)*
919/733-4283	North Carolina
701/224-2348	North Dakota
614/644-2727	Ohio *(or 800/523-4439 in state)*
405/271-5221	Oklahoma
503/229-5797	Oregon
717/787-2480	Pennsylvania *(or 800/23-RADON in state)*
809/767-3563	Puerto Rico
401/277-2438	Rhode Island

803/734-4700	South Carolina *(or 803/734-4631)*
605/773-3153	South Dakota
615/741-4634	Tennessee
512/835-7000	Texas
801/538-6734	Utah
802/828-2886	Vermont
804/786-5932	Virginia *(or 800/468-0138 in state)*
206/586-3303	Washington *(or 800/323-9727 in state)*
304/348-3526	West Virginia *(or 304/348-3427)*
608/273-5180	Wisconsin
3007/777-6015	Wyoming

Glossary

The field of radiation and radon have an extensive vocabulary, complete with its own set of technicalese and jargon. This abridged glossary includes just a few of the key terms reporters must understand to communicate meaningfully on radon as a public health issue.

Acute Effect -- An effect that becomes apparent after a one-time or brief exposure rather than being manifested only long after exposure.

Alpha Particles -- An energized particle made up of two protons and two neutrons that is ejected from from a radioactive atom. It is indistinguishable from a helium atom nucleus.

Beta Radiation -- A negatively charged subatomic particle (electron) emitted from a nucleus during some types of radioactive decay.

Chronic Effect -- An effect that becomes apparent only some time after exposure, as opposed to an acute effect, which develops with a one-time or short-term exposure.

Curie -- A unit quantity of a radioactive nuclide equal to 3.7×10^{10} disintegrations per second.

Decay Product -- Radioactive materials degrade to give rise to decay products, often referred to informally as "daughters" or "progeny." The radon decay products of most concern from a public health standpoint are polonium-214 and polonium-218.

Gamma Radiation -- Short-wave electromagnetic radiation.

Half-Life -- The time required for half the atoms of a radioactive substance present at the beginning to be disintegrated. For instance, beginning with 100 units, there would be 50 units not disintegrated at the end of the first half-life, 25 at the end of the second, and so forth.

Indoor Radon Abatement Act -- Passed in 1988 as Title III of the Toxic Substances Control Act, this law establishes as a national goal -- but not as a requirement -- that air within buildings "should be as free of radon as the ambient air outside of buildings." The law mandates development of model construction codes for controlling radon in new buildings; directs EPA to help states establish a radon information clearinghouse and provide states technical assistance; and authorizes $10 million annually for grants to states to develop and initiate radon assessment and mitigation programs. In addition, the law directs EPA to study radon contamination in schools, provide grants to colleges to establish radon training centers, and report to Congress by October 1, 1990, on radon in federal buildings.

Picocurie -- A curie is a standard measurement for radioactivity, specifically the rate of decay for a gram of radium -- 37 billion decays per second. A picocurie (pCi) is one millionth of one-millionth of a curie.
Polonium -- A radioactive metallic element that occurs in pitchblende and other uranium-containing ores.

Radium -- A highly radioactive white shining element found in pitchblende, carnotite, and other uranium-containing minerals. It emits alpha particles and gamma rays to form radon.

Radon -- An odorless, tasteless and invisible radioactive gas which occurs naturally in rocks and soils as a breakdown product of uranium. It is found in high concentrations in soils and rocks containing uranium, granite, shale, phosphate, and pitchblende, but it also is found in soils contaminated with certain industrial wastes (those from uranium or phosphate mining) and in underground water supplies.

Reading Prong -- A geographical area stretching throughout Pennsylvania, New Jersey, and New York known to have a high number of homes with high radon concentrations.

Working Level -- A working level, derived from safety and health regulations covering mining, is a measurement of radon decay products, rather than of radon itself. Roughly, one picocurie per liter of radon gas is the same as 0.005 working levels. So one working level (WL) is equal to about 200 picocuries of radon gas. The term itself generally is used less often than picocuries as a unit of measure.

Established in 1988, the Environmental Health Center (EHC), a division of the National Safety Council, operates as a not-for-profit, nongovernmental public service organization. In this capacity, the EHC is charged with helping diverse sectors of society better focus limited resources on the numerous environmental challenges which pose significant risk to the health and safety of its people and, therefore, to society overall.

The Environmental Health Center, through its projects and activities, strives to promote a broader understanding of complex environmental issues. The Center takes no "sides," except to support sound and workable environmental policies. Working with a broad range of public and private sector organizations, print and electronic media, citizen interest groups, and academic organizations, the Center assists in developing and implementing policies aimed at recognized public health risks.

The National Safety Council's EHC fosters improved communications not only among those professionally engaged in environmental protection and resource management, but also -- and most importantly -- among the public at large.

National Safety Council

EHC